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Battalion Level Tactical Decision Making: Can Automation Make a Difference?

A Monograph
by
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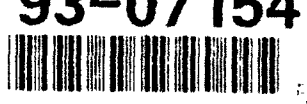

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BATTALION LEVEL TACTICAL DECISION MAKING: CAN AUTOMATION MAKE A DIFFERENCE? by MAJ Gregory J. Bozek, USA, 51 pages.

This monograph analyzes battalion level tactical decision making to determine if an automated system can facilitate decision making during combat. Danger, exertion, uncertainty, and chance are battlefield conditions under which the commander must operate. While technology has increased battlefield speed and lethality, improvements in command, control, and decision making have not kept pace.

This study first reviews command and control and decision making from theoretical and historical perspectives and then from the perspective of current and emerging doctrine to identify requirements for decision making. It then analyzes tactical decision making tasks and conditions to identify the criteria an effective system should meet. This study applies the criteria to manual and automated systems to identify their relative advantages and disadvantages to determine if automation can facilitate decision making and, if it can, what the proper mix of automated and manual systems should be.

This monograph concludes that automation can facilitate battalion level tactical decision making. To support the battalion commander's requirements during battle, his command and control system should be based on a manual system to support the intuitive, leadership, and human elements of command and control. Automated systems should support the commander's decision making capability and battlefield control by improving his situational awareness.

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INTRODUCTION

A commander's ability to read the battlefield, make quick decisions, and transmit his orders to his subordinates is fundamental to achieving battlefield agility. Technology has increased battlefield speed and lethality. While technology has also increased the commander's ability to collect information and "see" the battlefield, it has not kept pace with increased command, control and decision making complexities.[1] Technology has given commanders the capability to receive and transmit more information, but more information does not necessarily mean better and more timely decisions. Uncertainty, chance and friction are always present in battle and increased information alone will not overcome their effects. The US Army must use its technology to improve the commander's ability to make better, more timely decisions instead of adding to the friction of battle.

The current U. S. Army command and control system is manual and does not provide responsive support to battlefield commanders for their analysis and tactical decision making.[2] The Army Tactical Command and Control System (ATCCS) is a US Army automation program designed to resolve these deficiencies and ensure interoperability in the command and control (C2) process. ATCCS, however, focuses on corps to brigade

level. It does not support the armored or mechanized battalion commander's C2 and tactical decision making requirements.

The Armor School has been involved in a variety of programs to automate the battalion C2 system. The programs have included: the Battlefield Management System (BMS)[3], the Vehicle Integrated Intelligence System [V(INT)^2][4], the Combat Vehicle Command and Control (CVC2)[5], and the Inter-Vehicular Information System (IVIS)[6]. These programs have all focused on facilitating C2 by improving the ability of commanders, staffs, and crews to receive, assimilate, and process information.

This paper will analyze C2 and decision making from the perspective of an armored/mechanized battalion commander. It will specifically address whether the US Army can automate a battalion commander's information management functions to improve his tactical decision making capability <u>during</u> combat operations. This paper will review command and control and decision making from a theoretical and historical base, then from the perspective of current and emerging doctrine. It will then analyze tactical decision making tasks and conditions to establish criteria for an effective system. The study will apply the criteria for an effective system to manual and automated systems to

determine if automation can improve the battalion commander's decision making capability; and if it can, recommend an appropriate mix of manual and automated capabilities in a C2 system.

COMMAND AND CONTROL THEORY AND PRACTICE

The Theoretical Base.

Although warfare and the technology employed to wage battle have changed tremendously over the years, the great military theorists have analyzed aspects of information requirements and C2 that remain applicable today. Sun Tzu, Clausewitz, and Jomini wrote about the need for information to support the commander's decision making requirements.

Sun Tzu, writing over 2000 years ago, stressed the importance of the commander's intellectual faculty and his ability to gain information and use it to his advantage. He believed commanders must analyze the information they gained to understand the specific situation they are involved in--"a skilled commander seeks victory from the situation . . ."[7] Sun Tzu emphasized the importance of determining the enemy's disposition while concealing one's own.[8] He identified four key areas of information as critical to a commander's success: enemy forces, friendly forces, weather, and terrain. "Know the enemy, know yourself; your victory will never be endangered. Know the

ground, know the weather; your victory will then be total."[9]

Jomini wrote about the impossibility of achieving "perfect information."[10] His guidance to commanders on gaining information reflects the importance he placed on information. To paraphrase: Commanders should use whatever means they have available to gain information. They should use multiple means to acquire information so they can sift through it to gain the truth. Commanders should not rely on any single source of information because it may not be accurate. They should develop several courses of action so as they determine the actual situation the commanders have options.[11]

Like Sun Tzu and Jomini, Clausewitz emphasized the importance of information. He wrote that chance, friction and uncertainty are conditions under which the commander must operate and will affect everything they do. "Chance makes everything uncertain and interferes with the whole course of events."[12] He believed all action in war was subject to "friction." Friction is the undefinable force that makes even easy things difficult in combat. Clausewitz believed commanders must understand the effects of friction and, based on their experience and training, realize what is possible on the battlefield and what is not.[13] The commanders

must then make timely decisions based on available information:

> Since all information and assumptions are open to doubt, and with chance at work everywhere, the commander continually finds that things are not as expected . . . During an operation decisions have usually to be made at once: there may be no time to review the situation or even to think it through. Usually, of course, new information and reevaluation are not enough to make us give up our intentions: they only call them into question. We now know more, but this makes us more, not less uncertain. The latest reports do not arrive all at once: they trickle in. They continually impinge on our decisions, and our mind must be permanently armed, so to speak, to deal with them.[14]

Clausewitz and Jomini both addressed the intuitive capabilities of the commander to gain the truth from a situation, that others would not normally see, and make quick decisions. They referred to it as coup d'oeil or the "inward eye." Clausewitz described it as the "quick recognition of a truth that the mind would ordinarily miss or would perceive only after long study and reflection."[15] Jomini believed coup d'oeil was the most important characteristic of a commander and could be developed through training.[16]

These three theorists identified several important aspects of information and decision making. The following is a short summary of their ideas:

1. Quality information is important.
2. Commanders must be able to make decisions

quickly with available information.

3. Chance, friction, and uncertainty conspire to prevent one from attaining the truth on the battlefield.

4. Information about friendly forces, the enemy, terrain and weather are critical to properly analyze a given situation.

5. The intuitive capability of the commander, acquired through training and experience, is important in decision making.

Historical Evolution of Command and Control.

> The history of command can . . . be understood in terms of a race between demand for information and the ability of command systems to meet it.[17]

Mobile warfare has presented command and control challenges for commanders throughout history. Napoleon used a combination of organizational and procedural techniques to overcome technological shortcomings to effectively command his forces. Among other things, Napoleon empowered corps commanders with a delegation of authority to operate independently and he employed a two-way communication system to issue orders and receive feedback from his subordinates.[18] Advances in technology increased weapons' accuracy and lethality which caused the battlefield to become more fluid and dispersed. These effects combined to increase command and control challenges for commanders.

The introduction of the tank in September of 1916 along the Somme River added a new dimension to mounted warfare, but also added new complexities to battlefield command and control. The traditional use of semaphores or flares to control actions was no longer sufficient. Wireless sets in command vehicles initially proved insufficient to control formations. They did not provide efficient, reliable communications nor did they provide two-way communications between the commander and other vehicles in the formation. Some commanders were forced to lead their tank formations on foot to direct the action.[19]

Initial increases in communications capabilities limited the mobility of commanders. Radios and wire systems allowed them to command and control the operations of their dispersed formations, but the systems were immobile. They forced commanders to operate from their headquarters which were often miles from the battlefield. Improved radio communications allowed commanders to get out of their headquarters and command from the front.[20]

Martin van Creveld credits Heinz Guderian with recognizing how to command armored formations in combat.[21] In 1935, Guderian, who had studied Napoleon's command and control methods, realized he had to combine command techniques and technology to the

problem of commanding armored formations.[22] He developed the idea that, "Only leaders who drive in front of the troops will influence the outcome of the battle. . ."[23] Guderian aggressively campaigned to install radio communications in each tank because he understood the importance of two-way communications and that communications should not restrict the mobility of the commander. Command and control techniques and technology continued to develop throughout World War II as other armies witnessed the effectiveness of the German system and worked to refine their C2 systems.[24]

The combat environment of Vietnam was generally characterized by small unit actions and close quarters fighting. The tactical C2 innovation of the Vietnam War was the use of the helicopter. Although there are many examples of this capability taken to extremes with layers of commanders fighting a platoon's battle,[25] one can view the helicopter as a precursor to the capabilities BMS, CVC2, and IVIS are currently attempting to provide the battalion commander. The battalion commander increased his situational awareness by observing and then directing the combat actions from his helicopter above the action. The following two examples describe how commanders effectively used this capability but also illustrate the important aspects of

combat that their vantage point in a helicopter could not support.

On 8 June 1966, Troop A, 1-4 CAV was caught in an ambush by a Viet Cong Regiment. The Squadron Commander, LTC LeWane, supported the ambushed troop from his observation helicopter. He directed units to the right position, called close air support strikes, and effectively adjusted artillery fires. However, he realized supporting the fight from above was not sufficient.

> On two occasions in the heat of the battle, LTC LeWane landed his fragile H-13 inside the lager under heavy fire. He wanted to eyeball his troops and determine the state of their ammunition. He found them full of fight with plenty to shoot. His presence in the thick of battle was just what the troopers expected of their commander.[26]

The second example occurred during a battle on 6 September 1969 in a rubber plantation near Loc Ninh. MAJ John C. Bahnsen, Squadron Commander 1/11 ACR, successfully directed the squadron operations from his helicopter. One of the lessons learned from the operation was:

> Command from a helicopter gives better communications and usually better visibility and control, but does not normally outweigh the morale aspects of sharing ground troops' hazards under fire . . .[27]

These examples illustrate the importance of the human element in warfare even when technology has

provided a capability to improve the commander's battlefield C2.

Israeli experience in the 1973 War provided the US Army the ability to witness the speed and lethality of modern battle and learn about shortcomings in C2 organization, methods, and technology. Among the many lessons learned from the war, the requirements for a position locator system and improved communications equipment were apparent.[28]

US Army experiences in Desert Storm reinforced lessons learned from previous battles and introduced new technologies to augment C2. Satellites, Joint Surveillance and Target Attack Radar, unmanned aerial vehicles, and other high technology systems provided commanders a picture of the battlefield never before realized. At the tactical level the use of Global Positioning Systems provided a technological capability that was key to mission accomplishment.[29] But even with the high technology available, commanders stressed the importance of being in position to see the battlefield for themselves.

> Even in this age of modern technology, there is no substitute for the commander's presence forward to assess the situation and to make decisions affecting the synchronization of combat power. The clarity of information received at the command post may not be sufficient to paint an accurate tactical picture and valuable time could be lost trying to confirm the actual combat situation. The commander cannot afford to wait until all information has been gathered and processed. He

> must develop the ability, through training, to synthesize fragments of information and anticipate probable courses of enemy action or outcomes of friendly actions in order to maintain the initiative.[30]

This historical review points out some important aspects of C2 in battle that must serve as criteria in evaluating an effective C2 system:

1. Commanders must be able to move on the battlefield without reducing their command capability.

2. Two-way communications are critical.

3. Leadership is crucial in effective C2.

4. While technology can augment a commander's capabilities, he must still make decisions based on incomplete and contradictory information using his intuition and feel for the battle.

Current and Emerging C2 Doctrine.

US Army AirLand Battle Doctrine bases its approach to generating and applying combat power on the ability to secure and retain the initiative. The first precondition for gaining the initiative is battlefield agility.[31] Agility is "the ability of friendly forces to act faster than the enemy . . ." [32] There are physical and mental aspects of agility. Physically, units must be capable of responding quickly to orders or developing situations on the battlefield by changing formations, shifting the main effort or reorienting their focus. Mentally, leaders must have the

capability to see through the fog of battle, read the battlefield, decide on the necessary action, and issue orders to their units. To achieve battlefield agility, the C2 system must "facilitate freedom to operate, delegation of authority, and leadership from any critical point on the battlefield."[33]

Emerging doctrine describes the concept of "Battle Command." It blends C2 theory, battlefield experience, and doctrine. It acknowledges the personal side of command--the commander's personal judgment and leadership. It recognizes the environment the commander operates in--full of the fog and friction of battle. Battle command focuses on the role of the commander and is based on his tactical judgment and his feel for the battle.[34]

The commander achieves battlefield agility using the "running estimate." The commander must have the capability to see the battlefield through his own observations, reports and actions of his subordinates, and from any other inputs he may receive. He must envision what he wants the future state of the battlefield to look like. Based on his feel for the battle, he makes the necessary decisions and issues orders to make his envisioned future state a reality.[35]

Task Force (TF) doctrine, as described in FM 71-2, identifies the TF commander's requirements for gaining agility on the battlefield. The TF commander achieves agility by the following actions: understanding the enemy, terrain, and weather through a thorough IPB; positioning to see the battle; receiving accurate and timely reports and staff updates; having the ability to shift the main effort; making timely decisions and rapidly translating them into clear, concise orders; and maintaining flexibility.[36]

Army current and emerging doctrine and TF doctrine clearly articulate several requirements a C2 system must provide to support a commander's ability to achieve agility and gain the initiative on the battlefield.

1. Training and experience are critical as is the commander's and staff's thorough analysis of the situation before the operation.

2. To support our doctrine, a C2 system must also support the positioning of the commander on the battlefield. Command occurs where the commander is located on the battlefield and he should not be restricted in his movement.[37]

3. It should provide the commander access to critical information to support timely decision making.

4. The system should facilitate the commander's ability to articulate his orders to his subordinates and provide two-way communications to issue orders and receive feedback. It should also provide flexibility to adjust a plan to handle unforseen circumstances.

DECISION MAKING TASKS AND CONDITIONS

Plans are the initial basis for the conduct of a tactical operation, but a commander must expect the unexpected during the course of battle. The commander must continually make decisions and issue fragmentary orders to take advantage of battlefield opportunities and shift his effort.[38] The basic tasks associated with tactical decision making include: acquire information, maintain status, assess information, determine actions, and direct and lead subordinate forces.[39] The following analysis of the decision making tasks identifies key criteria by which to evaluate a C2 system.

Acquire Information

"Information is the raw material of decisions."[40]

In analyzing the C2 process, decisions are the products of the process, but information is the medium within which it works.[41] The theorists identified the importance of quality information. It is critical in the decision making process. It seems logical then that more information leads to better decisions. But

information by itself is meaningless unless it supports the commander in his situation analysis and contributes to his decision. Unnecessary information slows down decision making by adding to the processing time to handle the volume of information available, and hiding the truly important information in the clutter.[42]

Good information is needed for a C2 system to support effective decision making. The commander should establish filters to ensure he gets information to support his needs by establishing priority intelligence requirements and essential elements of friendly information. Once the commander identifies his information requirements, the critical information should not be filtered through unnecessary layers of staffs or intermediate headquarters. The quicker the critical information gets to the commander, the better it supports his decision making.

Various studies of communications and information requirements for commanders in simulated combat have identified some similarities in the information requirements for tactical commanders.

One study showed the information battalion and brigade commanders consider important to their decision making is generally the same as the information the staff needs.[43] This should streamline the information flow process because there is not a wide difference in

the critical information requirements throughout the headquarters.

Other studies indicated that critical information requirements are generally similar regardless of the type of mission or phase of an operation at battalion and brigade level. A small number of critical information elements accounts for a large percentage of the overall information needs. Information such as enemy unit status, friendly unit status, supporting fires availability, and mission requirements accounts for a large percentage of the information needs regardless of the type mission the unit conducts or the phase of the operation. The study results supported the importance of information that fall under the categories of mission, enemy, terrain, and troops available.[44]

In his paper Understanding and Developing Combat Power, Colonel Huba Wass de Czege supports the information requirements reported in the test. He identified three general information requirements commanders need to analyze a given situation. The leaders and staff must know the enemy, understand the effects of terrain on the operation, and understand the full range of their own unit capabilities to properly "read" the battlefield.[45] But data alone is not sufficient to support tactical decision making. There

is a component of information that raw data alone does not communicate.

Information requirements to support battlefield decision making can be quantitative--such as unit locations, size, or numbers of vehicles; or it can be qualitative. Qualitative information addresses the leadership aspects and intuitive feel of the commander required in decision making. There is a lack of historical analysis on the qualitative data that flow inside a command system used to make tactical decisions.

> Furthermore, even if such information were available, it is more than probable that they would have failed to capture many of what one suspects are precisely the most important aspects of command. The informal, and sometimes tacit, communication that goes on inside an organization; its vital, but ultimately undefinable, ability to distinguish between relevant and irrelevant information fed to it; the mental processes that, often unknown even to himself, do take place inside a commander's head; the tone of voice with which a report is delivered, or an order issued; the look on a man's face, the glimmer in his eye, when handed this or that message--none of these would be recorded.[46]

Even a C2 system that provides all the "right" information will not fully support the commander unless it allows the transmission and receipt of qualitative information to communicate the human side of command.

The task "acquire information" is the act of exchanging information about situations with subordinate commands.[47] A C2 system should meet the

following criteria to support the commander's ability to acquire information:

1. The system must support a flow of both quantitative and qualitative information.

2. The critical information must flow to both the commander and staff so they share a common picture of the battlefield while non-critical information, such as routine reports, flows to the staff only.

3. The general information required to properly read the battlefield at battalion level includes information about the mission, enemy, troops available, terrain.

Maintain Status

As the commander acquires information, he must have the capability to manage, store, display, and distribute it at the appropriate time to support his decision making.[48] To maintain status and track the progress of the operation the commander needs access to information at varying time intervals depending on the type of information. His information requirements fall into two general categories: continuous information and on-call information.[49] The battalion C2 facilities, organizations and equipment play key roles in facilitating the commander's ability to manage information, maintain situational status, and supervise operations.

C2 Facilities. At battalion level, the C2 facilities consist of three major command posts (CP): the main CP, the combat trains CP, and the field trains CP. The commander may elect to use either a tactical CP or command group to operate for short periods of time. The collective purpose of these facilities is to direct the battle and sustain the force.[50]

C2 Organization. The commander organizes his staff and assigns responsibilities to best support his method of operating. In determining the organization, commanders must decide on the trade-offs between dispersion of key individuals--specifically the commander, executive officer (XO), and S3--on the battlefield and their collocation. Dispersion improves the commander's ability to see and influence different portions of the battle by positioning key individuals at different locations. It also enhances their survivability. However, dispersion reduces their decision making ability by fragmenting their collective effort. Collocating key individuals allows them to use their collective abilities to enhance their information management, wargaming, decision making, and communicating their decisions.[51] The trade-off is enhanced integrated efforts vice increased vulnerability.

The commander typically organizes the S3, fire support officer and forward air controller into a command group which operates forward in the zone or sector to control the fight. FM 71-2 emphasizes there is no requirement for the people in the command group to collocate.[52] The XO runs the main command post with the S2, S3 Air, and other special staff officers. The battalion logisticians operate from the combat trains and field trains to support the operation. This organization provides the key personnel at various command posts in the battalion to best support the operation.[53]

From their command posts throughout the battalion, the staff *monitors* the battle to *maintain* status of their area of expertise to keep the commander informed with updates as requested or as required of his on-call information requirements. The commander tracks the battle, manages his continuous information requirements, and maintains his running estimate. The goal of the C2 facilities and organization is to achieve a common picture of the battlefield throughout the unit. Whether a leader is seeing the battle for himself or seeing the battle through the reports of subordinates, he should have a common understanding of what the battle looks like with other leaders in the unit.

C2 Equipment. Currently, the US Army has no specially designed commanders' vehicles to support their battlefield requirements.[54] According to Richard Simpkin, "If a satisfactory mount for the commander of a mechanized force has so far been found, I have not encountered it personally or vicariously."[55] Commanders typically operate from the turret of an M1 Tank or an M2 Bradley Fighting Vehicle. This limits their access to maps, radios, and direct face-to-face communications with their staff. Operating from a combat vehicle increases the commander's physical workload because he must operate his commander's station in the vehicle while fulfilling his command responsibilities. He does not have staff assistance, aside from his crew, to answer the radio, maintain status boards, or update his situation map. A combat vehicle does, however, give the commander the mobility and protection to operate with his forward units to influence the fight, see the battle, and move to positions to meet with subordinates on the ground.

To support the commander's ability to maintain status during the conduct of the operation, the C2 system should meet the following criteria:

1. It should provide him the capability to operate from a combat vehicle that looks like the other vehicles in his unit, yet provide him access to the

necessary maps and communications equipment to communicate both graphically and by voice with his staff and subordinates commanders.

2. It should give him immediate access to information that subordinates have reported while minimizing his physical workload of answering radios, maintaining status charts, and updating situation maps.

Assess the Information

There are two aspects associated with the task "assess the information." First, the decision maker must deal with uncertainty, chance and friction. The second aspect is the decision maker's own cognitive limitations in receiving and processing information.

Martin van Creveld wrote about information and the endless quest for certainty in war:

> From Plato to NATO, the history of command in war consists essentially of an endless quest for certainty about the state and intentions of the enemy's forces; certainty about the manifold factors that together constitute the environment in which war is fought, from the weather and the terrain to radioactivity and the presence of chemical warfare agents; and, last but definitely not least, certainty about the state, intentions, and activities of one's own forces.[56]

Uncertainty is a constant in war. A commander has two options in dealing with uncertainty to make timely decisions. He can increase his command and control system's capability to receive and process more information or he can learn to operate with less

information and recognize uncertainty and chance are present.[57]

With current battalion organizations, the size of the staff and their ongoing requirements will limit their capability to increase the amount of information they receive and process. The commander must, therefore, learn to operate under the conditions of uncertainty, chance and friction. He must ensure he identifies his critical information requirements so he gets relevant information to support his decision making. He must also recognize the reliability of the information he receives. Since he must make decisions before all information is available, the relevance and reliability of the information are critical. His running estimate will support his personal judgment in assessing the information.

The cognitive capabilities of the decision maker are a limitation to his ability to receive and process information, assess it, and make tactical decisions. Three factors impact on an experienced decision maker's ability to receive and process information to support his decision: the amount of information, the diversity of information, and the format of presentation.

The human mind is a limiting factor in using information to support decision making. It has the capability to store large amounts of information, but

the mind can only retrieve and work with small amounts of information at a time. Tests have shown that decision making performance on simulated battlefields tends to improve as the amount of information available to the commander increases up to an optimum level.[58] Psychologists have found that about seven to ten pieces of information provided to a decision maker is the maximum he can efficiently handle before his decision performance falls.

Spatial coding, or chunking, is one technique of grouping like pieces of information into a single code and reducing the effects of information overload. It is a technique of providing more information to a decision maker without increasing the overall number of information items he must process. A word is an example of chunking information. The mind does not see the word as individual letters or separate pieces of information. The mind sees a word as a single piece of information. Using decision graphics on a situation map is an example of how a C2 system can chunk information. It portrays unit designation, location and relative combat power in one quick picture. In tests, spatial coding, or chunking, of information has improved decision making accuracy.[59]

Another factor impacting on decision making is the diversity of the information presented. Information

diversity will overload the decision maker's ability to use the information and will produce similar effects to information overload.[60]

To overcome the effects of information overload and information diversity, the commander must ensure he identifies his critical information requirements to limit the overall amount of information that flows to him. The staff operating from other battalion C2 facilities should receive and process the routine or noncritical information to reduce the burden on the commander.

The final factor is format presentation. Even when the total amount of information presented is not excessive, the format may not support the decision maker's ability to receive the information. If the decision maker cannot readily receive the presented information, it will limit the amount of information he can process in a given time. This will impact on his processing capability similarly to information overload.[61] Use of standardized graphics and symbols is a technique to reduce the adverse effects of format presentation.

To minimize the effects of information overload, it is important to understand the limits of human capabilities within the C2 system and to employ technology to augment the decision maker and not

overwhelm him. The C2 system must present critical information in a manner that complements and enhances human capabilities and supports the decision maker's requirements.[62] To assist the commander in assessing information, the C2 system can support him in a variety of ways by meeting the following criteria:

1. The commander needs to be able to judge and understand the relevance and reliability of the information he receives.

2. The system should present information in a useable format by using standard graphics, symbols, or formats.

3. The system should support use of filters for critical information to get to the commander quickly while other information flows to the staff.

Determine Actions

Although human beings are not good at receiving and processing information from multiple sources, they are superb decision makers.[63] They have the ability to compare multiple courses of action against their experiential base and make a decision. The commander bases his estimate of the situation and his decisions on his analysis of the mission, enemy, terrain and weather, troops available, and time (METT-T).

The formal military decision making process provides a detailed commander and staff interactive

process and describes actions from mission receipt to mission accomplishment.[64] The military decision making process may be as detailed or streamlined as the situation permits. During the course of battle many of these decision making functions must occur in the head of the commander, with minimum assistance from his staff. The commander's running estimate based on his observations, inputs from his subordinates, staff updates and any other available information provides him a picture of the battlefield. The commander compares the current picture with his mental picture of his desired future end state. He uses his best personal judgment to determine, first, if a decision of any kind is required to change the focus of his unit to achieve the desired end state. If he determines a decision is required he mentally wargames his options and selects an appropriate course of action.

In supporting the commander's decision making ability, the system should allow him continuous and on-call access to information he has previously collected specifically focused on the areas addressed by METT-T.

Direct and Lead Subordinate Forces

Whenever possible, the commander should issue his orders face-to-face with his subordinates, ideally overlooking the terrain on which they must fight.[65] During the conduct of the battle, face-to-face

communications may be limited. Nonetheless, the commander must have the capability to clearly articulate the mission, his intent, and his concept to his subordinates.

After issuing the order, the commander must supervise and lead his subordinates through the conduct of the operation. He will continually repeat the tasks associated with tactical decision making as often as required until the unit has successfully completed the mission.

To assist the commander in issuing orders and supervising the execution, the C2 system should enable him to share a common picture of the battlefield with his staff and subordinate commanders and allow him to use graphics and a verbal description to articulate his fragmentary order.

Decision-Making Conditions

The decision making tasks are complicated by the conditions under which the commander must operate and tend to decrease decision performance.[66] The US Army role as a "Power Projection" force dictates that the forces must be capable of responding to global requirements.[67] This indicates the requirement to operate under a variety of climatic and environmental conditions. Regardless of the environment, the effects of time and moral factors are present in warfare. An

effective C2 system must be able to support commanders under these conditions.

Effects of Time

> If you can't see it happen, it's too late to hear about it back in a rear area and meet it with proper force. (Major General John S. Wood)[68]

Time has a major impact on the quality of decisions.[69] In combat time plays a crucial role in decision making. Tests have shown that commanders tend to act very quickly. In planning phases during the test, time to make decisions averaged about twenty minutes; during the preparation phase, about four minutes; and during execution, less than a minute.[70]

Doctrine describes the requirement to act faster than the enemy as a precondition to gaining the initiative on the battlefield. This is the basic decision making trade-off between the quality of the decision and its timeliness. A decision maker can spend time to gain information to reduce uncertainty. This should produce a better decision but it may not meet time requirements. Or the decision maker can make a decision quickly to take advantage of a battlefield opportunity, realizing he does not have all the available information.

The window of opportunity is a way of describing the time requirements a C2 system must support to facilitate decision making. It includes more than just

decision making. At the tactical level, it includes the ability to accurately report battlefield information in a timely manner. It extends through the commander's decision making process and his ability to articulate orders to his subordinates for execution. It also includes the ability of the unit to respond to any decision and act before their actions are preempted by enemy actions.[71]

Therefore, the C2 system must support the entire C2 process. It must facilitate two-way communications and it must be responsive. "The ultimate measure of command and control effectiveness is whether the force functions more effectively and more quickly than the enemy."[72]

Moral factors. Army doctrine describes leadership as "the most essential element of combat power. . ."[73] This acknowledges that even in this era of high technology, war remains a clash of wills. The courage of soldiers on the battlefield is critical and the commander must have the ability to influence his soldiers through his personal leadership.

Commanders lead their soldiers in a variety of ways. In many situations leadership by example and the demonstration of personal courage are key. Encouraging soldiers is another important means of exerting battlefield leadership.[74]

Any C2 system must facilitate the commander's ability to lead his soldiers. This implies the requirement to support the commander's ability to lead from the front to see and be seen. It should also support the commander's ability to talk directly to his subordinates to encourage and motivate them.

Clausewitz described the four elements that make up the climate of war as "danger, exertion, uncertainty, and chance."[75] These factors remind us that command and control in battle is not an exact science, but an art. Commanders--through training, experience, and leadership--can do many things to minimize the adverse effects of danger, exertion and uncertainty. Chance remains a reality that no amount of preparation or training will overcome. The unexpected continues to occur. An effective C2 system must account for the conditions of battle and provide the commander the needed flexibility to adjust his plan to deal with the unexpected.

SUMMARY OF TASKS AND CONDITIONS

This analysis of decision making tasks and conditions has identified several criteria essential to a C2 system that facilitate the commander's decision making capabilities. They are generally consistent with the criteria identified from the review of theory

and doctrine. The following is a combined list of the criteria. The C2 system should:

1. Allow the commander to receive and transmit both qualitative and quantitative information.

2. Provide the commander the capability to move on the battlefield and operate from his combat vehicle.

3. Minimize the physical workload of the commander in maintaining maps and status charts.

4. Minimize the unnecessary cognitive workload on the commander by providing critical information to the commander, through the use of command-designated filters, and presenting the information in a useable format.

5. Provide the commander two-way communications.

6. Provide accurate, near real-time information.

7. Allow access to critical information continuously and to other information as required.

8. Support the commander's ability to articulate orders and operations graphics.

9. Provide the commander the flexibility to deal with unforseen circumstances.

MANUAL AND AUTOMATED SYSTEMS

This section will analyze the general advantages and disadvantages of manual and automated systems. The above criteria are the basis for the analysis.

Manual systems.

As the name implies, manual systems consist of voice radio nets, paper maps and acetate overlays, hand-recorded status charts and manually updated situation maps.

A manual C2 system is generally slow and inefficient in handling large volumes of information. It does however, provide good two-way communications and it supports the rapid transmission of short, critical pieces of battlefield information.

A manual system does have some distinct advantages. It provides a means of communicating time-sensitive, critical information quickly. It is as mobile as the commander needs to be during combat. It is also a means of communicating not only quantitative data, but also qualitative data. Commanders can "feel" the confidence or concern of their subordinate leaders or exert their own leadership over voice nets through their tone of voice or carefully worded messages. It helps a commander judge the relevance and reliability of information he receives because he knows where the information is coming from. It allows for the human element which is so critical in combat.

In simulated battlefield tests when commanders and staff used both manual and automated systems they relied on voice communications for their time-sensitive

information, specifically dealing with tactics and the maneuver situation.[16] Even though manual systems are very inefficient, they do allow the transmission of time-sensitive and qualitative information that is so important in combat.

Commanders establish their own filters to control information flow and are dependent on their staffs and subordinate leaders to enforce the filters. Commanders must rely on their own situation maps and status charts or input from their staffs for their continuous or on-call information requirements to maintain their picture of the battlefield.

A commander has great flexibility to issue orders using a manual system. He can make a "net call" and instantaneously talk to his orders group to issue orders. He is, however, limited in his ability to change his operations graphics. Changing graphics manually is time consuming and can be inaccurate.

Manual systems are inefficient because of their limited ability to transmit large amounts of quantitative data. They rely on voice communications and transmit information only as fast as a person talks. Results from communications tests at the National Training Center highlight this inefficiency. Voice transmissions are dependent on somebody receiving the message at the destination. During these tests,

transmitters had to wait an average of 28 seconds for the receiver to respond to their calls.[77] Another inefficiency is the use of call signs and other radio procedures. During the same tests, "Fifty-two percent of all successful radio transmission time was involved with call signs and related procedures."[78]

Manual systems place a heavy physical workload on commanders. They must transcribe all messages or physically update their situation maps to maintain a record of the message. This is not only time consuming, but it can lead to inaccuracies.

Another source of inefficiency in a manual system is identifying and reporting vehicle and unit locations. As much as sixteen percent of radio usage during these tests was the result of position location discussions.[79] Once reported, the location is then only as accurate as the map reading ability of the individual. Many of these functions are computerized in the automated systems to improve efficiency and accuracy.

Automated systems.

The general functional elements of an automated battalion level C2 system include: computer generated interactive displays, a position/navigation (POS/NAV) unit, applications software, memory and processing units, and tactical radios.[80]

Automated C2 systems are characterized by their efficiency in handling large volumes of information and presenting it in a preprogrammed format for the decision maker's use. They do have their disadvantages though. Automated systems can handle more information than the decision maker can possibly use and they do not account for the human element of warfare.

An automated system can reduce the physical and cognitive workload of a commander. It can reduce the physical workload on the commander by automatically maintaining a situation map and updating unit statuses. Preprogrammed filters can reduce the commander's cognitive workload by ensuring information flows to the appropriate facilities and only critical information flows to the commander. It also provides leaders on-call access to information stored in the data base. The data base may include digital map data, information developed before the operation and information updated during the operation.

The automated system can improve reporting accuracy and timeliness. It can help provide a shared common picture of the battlefield by displaying friendly vehicle/unit locations and status, reports of enemy activity, changes in operational graphics, calls for fire, or routine reports. The graphics can be automatically or manually updated. The system can also

improve location accuracy by using a positioning system.

Although these systems provide many advantages, they are not panaceas. First, the system must interface with other automated systems, both laterally and vertically. If an automated system cannot communicate with the systems in supporting units or higher headquarters, it may increase the workload on commanders and staff instead of reducing it.

The automated system is good at handling large volumes of information, but it is reliant on voice communications to maintain the capability of passing qualitative information. And any system that has the capability of providing large volumes of information has the capability of reporting misleading information.[81]

> The commission of inquiry into the shooting down of an Iranian airliner in the Gulf War Zone by the USS Vincennes in 1988 concluded that the warship's Aegis anti-aircraft missile system, capable of identifying and engaging numerous targets at great range, using a large amount of "artificial intelligence" had performed faultlessly. The data had, however been 'misinterpreted' by the crew.[82]

There appears to be a tendency among leaders to reduce their command responsibilities and increase their control capabilities when presented with increased amounts of information. During tests of an automated system, platoon leaders performed simulated combat operations under three different conditions. In

condition one they performed a series of missions with no friendly or enemy information displayed, in condition two they were provided friendly information only, and in condition three they had friendly and enemy information displayed. The leaders performed significantly better, as expected, under condition two than condition one. But they did not perform as well under condition three as they did in two. The test conclusions stated the leaders demonstrated "a sense of confidence and aggressiveness with the knowledge of friendly positions."[83] When provided both friendly and enemy positions the platoon leaders "tended to remove themselves from the battle; relay information on enemy positions rather than direct their assets to counter the threat. . ."[84]

Indeed, automation can provide tremendous capabilities to battlefield commanders to facilitate their decision making. The automated system must complement and augment the decision maker's capabilities and not overwhelm him.

CONCLUSION

This paper began by asking whether the US Army can automate a battalion commander's information management functions to improve his tactical decision making capability during combat. To answer the question, this study reviewed decision making from a theoretical and

historical perspective, and then analyzed decision making tasks to determine what criteria an effective C2 system should meet to facilitate decision making. By analyzing manual and automated systems against the criteria and identifying relative advantages of each system, this study determined that yes, the US Army can automate a battalion commander's information management functions to improve his decision making capability. The appropriate mix of manual and automated systems must reflect the strengths of each system and more importantly the nature of warfare.

At the heart of any C2 system are the soldiers and leaders of the unit that must make decisions and execute plans under adverse conditions in combat. To support their actions, the C2 system at battalion level should be based on a manual system, augmented by an automated system. The manual system provides for the all important human element in combat of commanders leading their soldiers. It provides instant two-way communications between commanders to pass data and assessments of the situation to help "paint the picture" of the battlefield. The automated system should be designed to reduce the cognitive and physical workload on commanders[85] by providing a common picture of the battlefield throughout the unit. It can provide access to information continuously or as required to

meet the commander's information needs. It should provide commanders a display of operations graphics and automatically updated locations and statuses of friendly units. It should allow a commander to send a graphic representation of his order digitally while he describes his intent over voice nets. This mix of manual and automated systems will draw on the strengths of each system and emphasize the importance of leadership in combat. In essence a commander "leads manually" and uses the automated system to support his decision making and control by improving his situational awareness.

Several other questions arise about the system specifications as the result of this study. Many of these tests are ongoing. The exact specifications of the automated system are important: how big should the display unit be and where should it be positioned? Should every vehicle in the unit be equipped with automated systems? What should the orientation of the display be--north or the direction of travel? But there are other important issues that impact on our doctrine, organization, and training.

Automation will impact on the doctrine and tactics of small units. It will also impact on heavy/light task organizations of tactical units, joint operations, and coalition warfare.

There are many possible impacts in unit organizations. Automation may cause the US Army to change the leader-to-led ratio in organizations because of the increased control capabilities it affords. Perhaps the Army can reduce the number of weapon systems in platoon and companies because of potential increased combat power achieved through automation. Staffs at either battalion or brigade level may no longer be required because of the capabilities automation provides.

Similar issues affect training. How do we train junior leaders to develop the necessary skills to execute "Battle Command?" Automated systems will change the skills units must train to maintain proficiency. The dependability of the systems will impact on how much time must units devote to training manual skills as a back up to automated systems.

Many of these issues require extensive further study and testing. Some we will not solve until we have developed automation expertise throughout the Army. But automation at the battalion level can help the battalion commander and give him the C2 tools he needs to operate on the increasingly complex battlefield.[86]

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